

# MEANINGS OF LIMIT OF A FUNCTION ENRICHED BY MEANS OF REPRESENTATIONS AND MODES OF USE

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Some research on the conceptions of the limit in high school and university students shows that many of them have an intuitive notion of the limit, which they describe with terms such as tend, approach, reach, exceed and limit. Fernández-Plaza et al. (2013) described and interpreted the definitions of high school students on the concept of the finite limit of a function at a point in terms of structural aspects compiled and synthesized from previous research (e.g., Cornu, 2002). These aspects were adapted and validated in a reliable category system that allows the analysis of definitions of the limit concept in an orderly, systematic and replicable manner (González-Flores et al., 2021). The work highlighted the dual concept of object-process that students attributed to the limit. Using these categories, which are supported by a theoretical framework related to Frege's semiotic triangle based on reference, sign and sense, we analyse the enrichment of the meaning of limit of Calculus' students at the National University of Costa Rica not only when defining but also when representing and provide modes of use of this notion.

From representations and modes of use expressed by the students, the findings include that graphic representation is the most used by students and also is the representation that provides more information from all our categories of analysis. Though a minority of students provide vague applications for the concept of limit, almost all students offer several terms and modes of use for this concept. We emphasize that, although representations and modes of use are not usually required in a standard definition of limit, they are essential to utterly construct its meaning. We conclude that the use of different representation systems and the mention of applications, and terms and modes of use of the limit enrich the meaning that students express of this notion. Expressing ideas about the limit in other way than defining is nothing more than completing conceptions of the limit.

## References

- Cornu, B. (2002). Limits. In D. Tall (Ed.), *Advanced mathematical thinking* (pp. 153-166). [https://doi.org/10.1007/0-306-47203-1\\_10](https://doi.org/10.1007/0-306-47203-1_10)
- Fernández-Plaza, J. A., Ruiz-Hidalgo, J. F., Rico, L., & Castro, E. (2013). Definiciones personales y aspectos estructurales del concepto de límite finito de una función en un punto. *PNA*, 7(3), 117-130.
- González-Flores, Y., Montoro-Medina A. B., & Ruiz-Hidalgo, J. F. (2021). Análisis de las definiciones de límite que brindan estudiantes universitarios. *UNICIENCIA*, 35(2), 1-20. <http://dx.doi.org/10.15359/ru.35-2.18>